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FOSSILS

on

Federal & Indian Lands



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A little more than a year ago, Congress asked me to review federal policy concerning fossils. Six bureaus of the Department of the Interior went to work on the task – the Bureau of Land Management, the Bureau of Reclamation, the Bureau of Indian Affairs, the Fish and Wildlife Service, the National Park Service, and the U.S. Geological Survey -- along with the U.S. Forest Service and the Smithsonian Institution. These agencies considered whether current federal policies and standards adequately prevent deterioration and loss of fossils and sufficiently promote science and education. The report accompanying this letter documents that there is much good to report; however, we have much left to do before success can be claimed.

The agencies concluded that fossils on federal lands often needlessly deteriorate or disappear through theft, vandalism and other causes and that the problem is exacerbated by lack of personnel and resources for assessment, management, and protection. Fortunately, the problem can be turned around through a combination of agency and Congressional efforts.

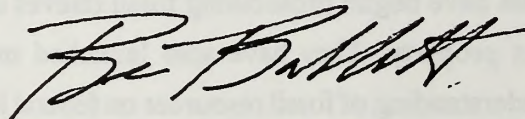
The agencies have begun prosecuting fossil thieves under laws generally prohibiting theft of government property. They have also launched multiagency, multidisciplinary studies to enhance understanding of fossil resources on federal lands and they have stepped up education efforts. I welcome these initiatives and have asked the Smithsonian Institution and the seven federal agencies that prepared this report to keep working together as a team to move us forward with partnership and action.

Renewed Congressional attention also could advance significantly federal policy on fossils. While fossils are different from cultural resources, Congress should consider the merits of action on a framework for fossils analogous to the Archaeological Resources Protection Act. In formulating any actions, Congress should consider, among other things: the need for stiffer penalties for those who damage and steal certain fossils and more resources to enforce the law; the need to move forward with cost-effective new technologies for research and conservation;

the need for regional studies and partnerships with amateurs and the academic community; and the need to do a better job at inventory and monitoring of fossil resources.

One key area for progress is making federal fossils more accessible for scientific study and public enjoyment. The federal agencies plan to continue their responsibilities of fossil ownership and to provide curation by agency and non-federal museums. However, this job requires resources. For example, the Department of the Interior's curatorial standards address documentation, preservation and protection of federal fossil collections, but the lack of funding prevents some federal agencies from meeting those standards. New online technologies can help by making information about collections and digital images of key specimens available to researchers and the public over the Internet. New and efficient technologies, however, require support.

The fact that fossils exist at all, surviving the forces of nature for millions of years, is awe-inspiring. But now many are disappearing fast. As Americans, we have a choice - we can allow these fossils and the information they hold to fall apart and disappear forever, or we can do what is needed to protect them for generations to come. This report recommends that we move forward and make certain that inattention does not deprive us of the best information we will ever have about our deepest past.



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Assessment of Fossil Management on Federal & Indian Lands



May 2000

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The map on the back cover of this report shows Federal and Indian land as discussed in the text.

EXECUTIVE SUMMARY

This report was prepared in response to Congress's request for an assessment of the need for a unified federal policy on the collection, storage and preservation of fossils and for standards that would maximize the availability of fossils for scientific study. Eight "consulting agencies" — the Bureau of Indian Affairs, the Bureau of Land Management, the Bureau of Reclamation, the Fish and Wildlife Service, the Forest Service, the National Park Service, the Smithsonian Institution and the U.S. Geological Survey — contributed to the report.

Fossils are non-renewable and (except for microfossils and those that make up the energy minerals) relatively rare resources with significant scientific, educational, commercial and recreational values. Fossils on Indian lands with commercial value are managed as trust resources, for the economic benefit of the Indian landowner. Fossils on federal lands,¹ on the other hand, are managed for their scientific, educational and, where appropriate, recreational values. The consulting agencies' collection requirements reflect their varying legal mandates and missions, as well as their attempt to balance the competing values of fossils. The differences among the agencies in inventory and monitoring efforts are due largely to varying amounts of acreage, staff and funding. Other components of fossil management — storage, preservation and information dissemination — are generally consistent across agency lines.

Development of the report involved an assessment of current policies and practices, documented in a background paper. Comments were solicited from the public through an open meeting in June 1999, and through two opportunities for written input. All comments were carefully read and considered. As with other land management issues, the principles and recommendations in this report respond to a wide range of input from the public, and some of the comments received could not be implemented.

The majority of comments received commended the agencies for their work in addressing difficult issues. Three themes emerged repeatedly. First, an overwhelming number of people expressed the view that fossils are part of America's natural heritage. Second, most people recommended that vertebrate fossils, because of their rarity, receive continued protection under a system that requires trained individuals to oversee collection of the specimens and the accompanying data. They also strongly supported keeping these scientifically important specimens in the public trust in order to provide a public benefit over long periods of time. Third, support for the involvement of amateurs as an integral part of both the science and the enjoyment of paleontology was universal. Many examples of amateurs' contributions made it clear that professional paleontologists welcome and value their relationships with groups and individuals.

Some amateurs were concerned that the recommendations in the draft report were in fact new restrictions on their hobby. This is not the case. On lands administered by the BLM, amateurs are welcome (see Table 1 and Principle 3). Protection for rare types of plants and invertebrates is established by the BLM on a geographic case-by-case basis, so that areas where collecting is not allowed must be clearly posted.

¹ Federal lands: for the purposes of this report, 'federal lands' refers to the lands managed by the BLM, BOR, FS, FWS, and the NPS.

As a result of assessing the need for a unified policy toward collection, storage and preservation of fossils, and the accessibility of fossils for scientific study and education, the consulting agencies have concluded that a fundamental level of uniformity already exists, and that administrative and Congressional actions pertaining to fossils should be governed by seven basic principles.

Principle 1: Fossils on Federal Lands are a Part of America's Heritage

- Fossils are unique resources. Without fossils, human beings would have little understanding of the development of ancient life on earth.
- Of all the organisms that have ever lived, only a tiny proportion have been preserved, exposed to view, discovered and appropriately collected.
- The condition, availability and scientific significance of the fossils on federal lands are among the best in the world.
- Federal agencies' current management practices further the paramount scientific and educational values of fossils.

Recommendation: Future actions should reaffirm the current use of federal fossils for their scientific, educational and, where appropriate, recreational values.

Principle 2: Most Vertebrate Fossils are Rare

- Relatively few sites worldwide contain dense accumulations of vertebrate fossils, and only a fraction of these sites are located on federal lands in the United States. Advocates for increased collection of vertebrate fossils on federal lands often overestimate these fossils' abundance.
- Federal agencies therefore uniformly limit the collection of vertebrate fossils to qualified scientific and/or educational personnel.

Recommendation: Future actions should reaffirm the restriction of vertebrate fossil collection to qualified personnel, with the fossils remaining in federal ownership in perpetuity.

Principle 3: Some Invertebrate and Plant Fossils are Rare

- Although invertebrate and plant fossils generally are more abundant than vertebrate fossils, some are nonetheless extremely rare.
- The agencies' varying collection policies for invertebrate and plant fossils reflect the agencies' missions and attempt to satisfy the wide range of public interest in these fossils.
- The agencies will work to reduce the potential public confusion about the varying collection policies.

Recommendation: Future actions should reaffirm mission-specific agency approaches to the management of plant and invertebrate fossils.

Principle 4: Penalties for Fossil Theft Should be Strengthened

- Hundreds of fossils are stolen from federal lands every year. Such thefts reduce access by scientists and the general public to scientifically significant and/or instructive fossils and destroy the contextual information critical for interpreting the fossils.
- The difficulties of establishing the commercial value of a stolen or damaged fossil may hinder effective prosecutions of fossil theft and damage. Commercial value also does not necessarily reflect the scientific and educational values of fossils.
- Agency efforts to enhance awareness on the part of the public, scientists and law enforcement personnel about the various values of fossils and the damage caused by fossil theft would eventually facilitate effective prosecutions. This, in turn, would more effectively deter future theft and damage.
- Notwithstanding public education campaigns and increased penalty provisions, fossils will continue to be stolen from federal lands unless agencies can place more trained personnel in the field.

Recommendation: Future actions should penalize the theft of fossils from federal lands in a way that maximizes the effectiveness of prosecutions and deters future thefts. Penalties should take into account, among other factors, the value of fossils themselves, as well as any damage resulting from their illegal collection. Future program strategies should emphasize education of federal managers, prosecutors, law enforcement personnel and the judiciary regarding the value of fossils and the techniques for the appropriate protection of fossil resources.

Principle 5: Effective Stewardship Requires Accurate Information

- Inventories and monitoring of fossils on federal lands are critical for sound fossil management. Thorough inventory data enables informed decision making and enhances interagency collaboration.
- New technologies, the help of amateurs and volunteers and partnerships can improve the cost effectiveness of information gathering and analysis. However, on-the-ground inventories by professionals will remain important in assessing agency fossil resources.

Recommendation: Future actions should acknowledge the need for gathering and analyzing information about where fossils occur, in particular the critical role of inventory in the effective management of fossil resources. Increased emphasis on fossil inventory should take into consideration, where possible, regional approaches across agency lines, using modern technology such as Geographic Information Systems (GIS). Such work could also address specific issues, such as the impact of erosion on the loss of resources.

Principle 6: Federal Fossil Collections Should be Preserved and Available for Research and Public Education

- Scientifically valuable fossils must remain in public ownership in order to be adequately preserved and available for science and public education.

- Federal agencies currently strive to meet the needs of scientists and the general public by housing fossils in both large research institutions and small community-based institutions, as well as federal repositories.
- Enhanced use of online databases, images and other information technology would maximize the availability of existing and future museum fossil collections to scientists and the public.

Recommendation: Future actions should affirm the importance of curating scientifically valuable fossils as federal property, often in partnership with non-federal institutions. Future program approaches should emphasize the use of modern technology to improve curation and access, as well as the sharing of information between and among government agencies and other institutions.

Principle 7: Federal Fossil Management Should Emphasize Opportunities for Public Involvement

- The public, including properly-trained amateurs and volunteers, have been and should continue to be a critical part of the management of fossils on federal lands.
- Public education is critical in the management of fossils on federal lands.

Recommendation: Future actions should include an emphasis on public education and participation in the stewardship of fossil resources. Future program approaches should emphasize the use of technology to increase public education and awareness of the importance and benefit of fossil resources.

I. INTRODUCTION

Purpose and Scope of Report

This report responds to Senate Report 105-227 on the Fiscal Year 1999 Interior and Related Agencies Appropriations Act. The Senate Report states that the “Secretary of the Interior, in consultation with appropriate scientific, educational and commercial entities, should develop a report assessing the need for a unified Federal policy on the collection, storage and preservation of . . . fossils.” The Senate Report further states that “the report should evaluate the effectiveness of current methods for storing and preserving fossils collected on public lands . . .” The Senate Report also encourages the Secretary of the Interior to assess the need for standards that would “. . . maximize the availability of fossils for scientific study.”

As a follow-up to Senate Report 105-227, Senators Tom Daschle and Tim Johnson sent a letter to the Secretary of the Interior. In their letter dated November 5, 1998, the Senators requested “recommendations as to how to structure . . . a [unified Federal] policy” including necessary “legislative action.” Furthermore, the Senators urged the Secretary to include “recommendations to improve our ability to preserve and study fossils collected on public lands.”

The agencies directed by the Senate to assist the Secretary of the Interior in preparing this report (consulting agencies) include the Bureau of Land Management (BLM), the Forest Service (FS), the National Park Service (NPS), the Fish and Wildlife Service (FWS), the Bureau of Reclamation (BOR), the Bureau of Indian Affairs (BIA) and the Smithsonian Institution (SI). The U.S. Geological Survey (USGS) also contributed to the report because of its special expertise in the earth sciences.

In this report, the consulting agencies assess the need for a unified federal policy for collecting, storing and preserving paleontological specimens. This report recommends that federal fossil management would be enhanced by a comprehensive approach for protecting and managing these important resources. Such actions should be governed by the seven overarching principles outlined in this report.

Developing the Report to Congress

The consulting agencies used the following process in writing this report:

- Identified and discussed the significant policy issues concerning collecting, storing and preserving paleontological specimens and prepared a summary of these issues.
- Identified relevant departmental manuals, regulations and agency handbooks to assist outside parties in their review of the federal government’s policies on collecting, storing and preserving paleontological specimens.

- Prepared a background paper on the federal government's existing practices for managing collection, storage and preservation of paleontological materials and published a notice in the *Federal Register*, 64 Fed. Reg. 27803-27804 (May 21, 1999), of a public meeting on June 21, 1999, and the availability of the background paper; distributed the notice to key professional societies, organizations and major scientific, educational and commercial entities concerned with collecting, storing and preserving paleontological specimens.
- Sponsored the public meeting to solicit the views of representatives from various interest groups and the general public; reviewed the relevant public input.
- Prepared an outline, based on the information secured above, of the topics to address in the report to Congress.
- Prepared a draft report and published in the *Federal Register*, 64 Fed. Reg. 58094 (October 28, 1999), a notice of the availability of the draft report and distributed the notice to attendees of the public meeting.
- Prepared the final report, including a review of comments received, for submission to Congress.

II. VALUE OF FOSSILS

Do fossils have scientific value? Yes. Fossils are the remains, imprints and traces of once-living organisms preserved in the earth's crust. They may be bones and teeth, shells, leaf impressions, footprints, or burrows. The fossil record is our only evidence of more than 3.5 billion years that life has existed on earth. Fossils show us that:

- the first organisms on the planet were similar to living nonphotosynthetic bacteria,
- there was a great diversification of multicellular animals in the oceans about 540 million years ago,
- the first plants lived on land about 400 million years ago,
- four-legged creatures first walked on land about 350 million years ago,
- dinosaurs evolved about 220 million years ago, and
- mammals and modern birds became very diverse about 65 million years ago.

Fossils show how the physical earth has changed over time. By studying them we can investigate the effects of climatic change over long periods of time. Fossils show us that:

- the climate has warmed and cooled,
- the positions of continents have changed, and
- mountains have been lifted up from ocean bottoms or continental lowlands.

Fossils also document the way living things respond to changing conditions. Without them, we cannot understand the history of life on earth. The fossil record lets paleontologists test their ideas about how the world works. Fossils reveal and help us understand:

- mass extinctions of species at several times in the history of the planet,
- periods when many new forms appeared in a short time,
- genealogical relationships of living species to one another,
- rapid environmental changes in the past,
- effects of human-caused changes to the earth's environment, and
- effects of environmental changes on biological diversity and ecological structure.



Both children and adults enjoy learning about fossils, not only in museums but also in the field.

What role do fossils play in education? Fossils play an important role in education. This is because paleontology, the study of fossils, is a science that combines geology, biology, chemistry and physics in an effort to understand the origin of our world and ourselves. Even the most reluctant student is fascinated by the past, especially when the lessons include dinosaurs and other intriguing fossils in a way that stimulates his or her curiosity and imagination. Fossils are an ideal means for teaching how science works.

Do fossils have commercial value? Yes. Complete fossils have commercial value. Many fragments do as well. Many fossils, like objects of art or gemstones, are rare, beautiful or awe-inspiring; others are merely curiosities. There is a market for both the rare and exotic and the relatively mundane. Even before there was the science of paleontology, people collected fossils to sell them to museums or private collectors. One tension in the discussion of appropriate fossil management arises from the fact that fossils with high commercial value often have high scientific value.

III. MANAGEMENT OF FOSSILS ON INDIAN LANDS

Bureau of Indian Affairs

The authority of the Bureau of Indian Affairs (BIA) to manage fossil resources on Indian lands is limited and not mandated by statute. The BIA's responsibilities are different from land managing agencies within the Department, such as the BLM or the NPS. Indian lands are lands that the United States holds in trust. These lands are subject to a restriction against alienation imposed by the United States because they are for the benefit of an Indian tribe or an individual Indian. The Government does not exercise the same rights of ownership or control over these lands as it does over federal lands.

The government's role in managing Indian lands is that of a trustee. As a trustee, the BIA approves realty transactions or business arrangements with non-tribal parties that are initiated by an Indian landowner, and this approval is not discretionary. It is based on a determination that the transaction is to the benefit of the Indian landowner.

Fossils that have commercial value have been found to be trust resources, and the BIA must manage the fossils as a trust resource. In managing trust resources, the BIA is limited to approving either leases of Indian lands, or contractual agreements between Indian landowners and third parties for the extraction of such fossils. The criterion for these approvals is that the arrangements are of economic benefit to the Indian landowner. The arrangements are also subject to evaluation under the National Environmental Policy Act (42 U.S.C. §§ 4321-4347) and the National Historic Preservation Act (16 U.S.C. §§ 470-470x-6.).

Since Indian lands are lands held in trust, the Indian tribe or individual Indian landowners may use fossil resources for their economic benefit. The BIA's role in these transactions is to ensure that the transaction benefits the Indian landowner. The BIA has no other authority to manage paleontological resources within its jurisdiction.

Access

If individuals or scientists are interested in access to fossils on Indian lands, they must get in touch with the tribe or individual landowner and request permission. The tribe or individual Indian landowner may deny access to their lands or may allow access with certain restrictions. It is up to the Indian landowner, not the BIA, to determine who has access to their lands and under what conditions that access will be permitted. Scientists are encouraged to work directly with the tribe or individual Indian to secure permission for research.

IV. MANAGEMENT OF FOSSILS ON FEDERAL LANDS

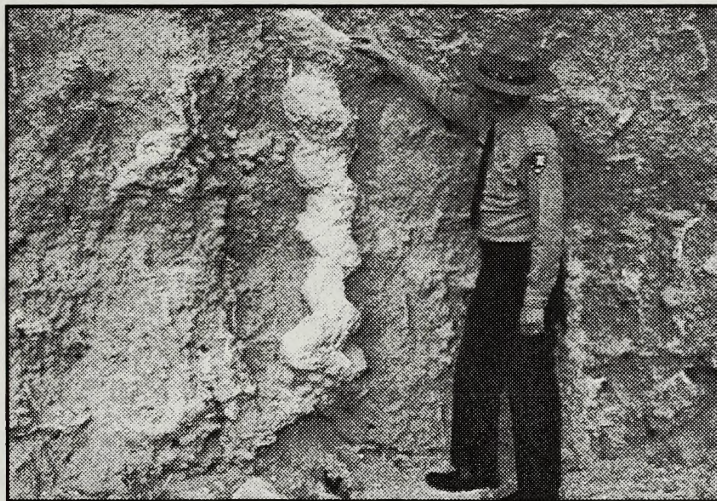
Fossils are non-renewable resources. The consulting agencies' principal existing goals for the management of fossils from federal lands are to safeguard their intellectual and educational values and to promote their public benefits.

To explain to the public how the consulting agencies' management of fossils furthers these goals, the agencies developed a background paper prior to the June 21, 1999, public meeting. The management components described in the background paper included:

- field inventory, monitoring and protection,
- collection requirements,
- storage and preservation, and
- information management.

The background paper is summarized briefly below. In addition, Appendix A contains a summary of agency-specific policy and practice.

Field Inventory, Monitoring and Protection



This 21-million-year-old beaver burrow can be seen at Agate Fossil Beds National Monument, Nebraska.

The consulting agencies take somewhat different approaches to performing inventories and monitoring the condition of fossil resources on the lands they administer. Varying levels of acreage, staff and funding, as well as different mandates, make this appropriate.

Currently, the BLM and the FS rarely have funding for inventory work prior to receiving project proposals. These agencies therefore conduct paleontological resource inventory and monitoring on a case-by-case basis. When notice of a proposed land use is received, a determination is made whether significant resources may be impacted, and whether a field survey is necessary to locate them. Fossils may be collected, documented and sent to a repository before or during a project.

Similarly, the NPS has no Servicewide funding source for paleontological resource inventory and monitoring. As a result, only a few national park units (of the 130 known to have significant paleontological resources) have completed comprehensive paleontological resource inventories. These inventories address land managers' day-to-day concerns, such as fossil resource protection, interpretation, curation and research. Yet the fact that so few inventories have been completed means that the fossil resources in many park units are unknown and unprotected.

The Bureau of Reclamation conducts paleontological inventories as targeted by resource management plans.

The consulting agencies are now developing cost-effective strategies, using new technology for identifying areas that are most likely to contain significant fossils. After existing data have been compiled, reconnaissance fieldwork can be planned and implemented. In some cases, amateur paleontologists might be partners in paleontological inventories through participation in the supervised search for, excavation, preparation and curation of fossils from federal lands.

In order to maximize the scientific and educational value of fossils from federal lands, managers must also take into account the natural processes of erosion. Monitoring the condition of fossils and fossil localities provides a picture of how these resources change as they become exposed. However, no comprehensive study has been done to document the contribution of erosion to the loss of the fossil record, the variation in rates of loss and the best methods of addressing such loss.

The public appetite for owning part of the fossil record, fueled in part by large commercial shows and sales on the Internet, shows no sign of decreasing. While there are laws that deal with theft and vandalism, these crimes increasingly affect fossils and have become a problem on federal lands. Land managing agencies, in addition to gathering baseline and follow-up data, investigate and prosecute incidents of resource theft and vandalism.

Collection Requirements

The policies for collecting scientifically significant fossils on federal lands are premised on the paramount values of research and education. When such fossils are collected by inexperienced people, or when collectors fail to maintain precise information on the original location, rock type, or other conditions of a fossil occurrence, the fossils can be damaged or they can lose their context and much of their value as objects of study. Even when fossils are collected by qualified personnel, agencies must consider the potential impact of the collection process upon other significant resources, such as threatened and endangered species and cultural resources. (See, for example, the discussion of Sacred Site considerations at the end of this section.) These are the main reasons why federal agencies regulate fossil collecting on federal lands.



Smithsonian Institution paleobotanist and volunteers collecting fossil plants for scientific study on BLM-administered lands in Wyoming.

Tables 1 and 2 explain each agency's policies that govern fossil collecting. The variations in policy summarized in Tables 1 and 2 reflect the different legal mandates and missions of the consulting agencies. That is, the NPS is preservation-oriented, and its policies keep all fossils in the public trust and only allow collection for scientific and educational purposes. On the other hand, the BLM has a multiple use mission. Therefore, some fossils (vertebrates) are preserved for scientific study, while other fossils (plants and common invertebrates) are generally available for recreational and educational use. These collection policies are generally appropriate to the agency and bureau-specific missions, and make it possible for agencies to meet a variety of needs for research, public education and recreation. These differences largely preclude a single federal fossil collection policy. The exception is the restriction of vertebrate fossil collecting to qualified personnel.

Table 1: Practices of the DOI for Collecting Fossils

Agency	Invertebrates	Vertebrates	Petrified Wood	Other Fossil Plants
BLM	Reasonable amounts for personal use, no permit required	Must have a permit	Up to 25 lbs/day/person + 1 piece; not to exceed 250 lbs/year, for noncommercial use. BLM treats petrified wood as a mineral material	Reasonable amounts for personal use, no permit required
BOR	Permit required; scientific purposes only	Permit required; scientific purposes only	Permit required; scientific purposes only	Permit required; scientific purposes only
FWS	Special Use permit required; scientific or educational purposes only	Special Use permit required; scientific or educational purposes only	Special Use permit required; scientific or educational purposes only	Special Use permit required; scientific or educational purposes only
NPS	Permit required; scientific or educational purposes only	Permit required; scientific or educational purposes only	Permit required; scientific or educational purposes only	Permit required; scientific or educational purposes only

Table 2: Requirements for Obtaining a Scientific Collecting Permit

Agency	Qualifications	Permit Types	Other	Repository
BLM	Graduate degree in paleontology or related topics; or equivalent experience with one who meets that standard	Survey/limited surface collection (<1 sq m disturbance); or excavation (1 sq m surface disturbance or more)	Reports required annually and at the end of project. Work in Special Mgmt Areas requires additional reviews	Designated by permit applicant; must meet DOI/BLM standards
BOR	Similar to BLM	Scientific collecting permit	None	Designated by BOR or permit applicant; must have letter from repository showing intent to accept specimens
FS	Same as BLM	Varies with forest unit, from survey and inventory to excavation and collection	Reports required annually and at the end of project. Work in Wilderness Areas may be restricted	Designated in application for Special Use Permit; must meet FS standards. Standards added to permit
FWS	Related to nature of work	Special Use permit required for survey or collection	Reports required at the end of the project	Similar to BLM
NPS	In revision; qualifications and experience to conduct scientific study or represents reputable scientific or educational institutions or state/federal agencies	Scientific research and collection	Reports required annually	At NPS units, or in an approved repository designated by permit applicant; must meet DOI/NPS standards

Indian Sacred Sites

All federal agencies with jurisdiction over federal lands must also be in compliance with the President's Executive Order on Sacred Sites (E.O. 13007, May 24, 1996). The Executive Order states that each executive branch agency with statutory or administrative responsibility for the management of federal lands shall, to the extent practicable, permitted by law and not clearly inconsistent with essential agency functions: (1) accommodate access to and ceremonial uses of Indian sacred sites by Indian religious practitioners and (2) avoid adversely affecting the physical integrity of such sacred sites. Collecting fossils on federal lands may impact Indian sacred sites. Therefore, collectors must comply with the Executive Order, agency policies, or procedures developed pursuant to this Executive Order. See Department of the Interior Manual, Part 512, Chapter 3: Departmental Responsibilities for Protecting/Accommodating Access to Indian Sites.

Storage and Preservation

Fossils collected by scientists from federal lands are placed in museums to:

- keep them safe,
- maintain their physical condition,
- keep fossils and information together, and
- make the fossils and their context available for scientific study and for current and future educational and interpretive programs.

Land managing agencies work through the permitting process to ensure that fossils collected by scientists from federal lands are available for exhibit, research and public education. Fossils collected by scientists under permits issued by the various agencies remain the property of the federal government, and as such, are the property of all Americans. Many comments received at the public meeting on June 21, 1999, and in written format, strongly supported the current practice of keeping fossils collected under a permit in the public trust. Many natural history museums are undergoing a surge of building and renovation, and are able to provide excellent levels of care for both specimens and data. However, some institutions are concerned about their continuing ability to curate specimens properly and make them available to the public through display and education.

The Department of the Interior sets and maintains standards for the storage, preservation and care of collections under Departmental Manual 411. Other documents, such as NPS Museum Handbooks and the NPS Natural Resources Management Reference Manual, add specific direction. The Smithsonian Institution, with decades of experience and extensive resources, is an excellent source of expertise on fossil storage and preservation.

Information Management

Although all the consulting agencies have developed approaches to information management including Geographic Information Systems (GIS) and Hypertext Markup Language (HTML), there is no current structure for a systematic approach to sharing information across agencies. Many databases are accessible on the Internet. Repositories that hold federal collections must

meet certain standards for maintaining not only specimens, but also the contextual information that accompanies them. However, these institutions often lack sufficient resources to share information among themselves or with the broader public. Although many museums have put some of their catalogue information in digital databases, much more could be done with additional funding to maximize the usefulness of fossils to a wider audience, including the general public, students, land managers and researchers. Despite funding limitations, many institutions have developed creative educational programs in which the public can learn about fossils collected from federal land.

Table 1. Summary of the data presented in this report.

Area	Summary of Data
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V. RECOMMENDATIONS FOR FURTHER ACTION

Tribal Land

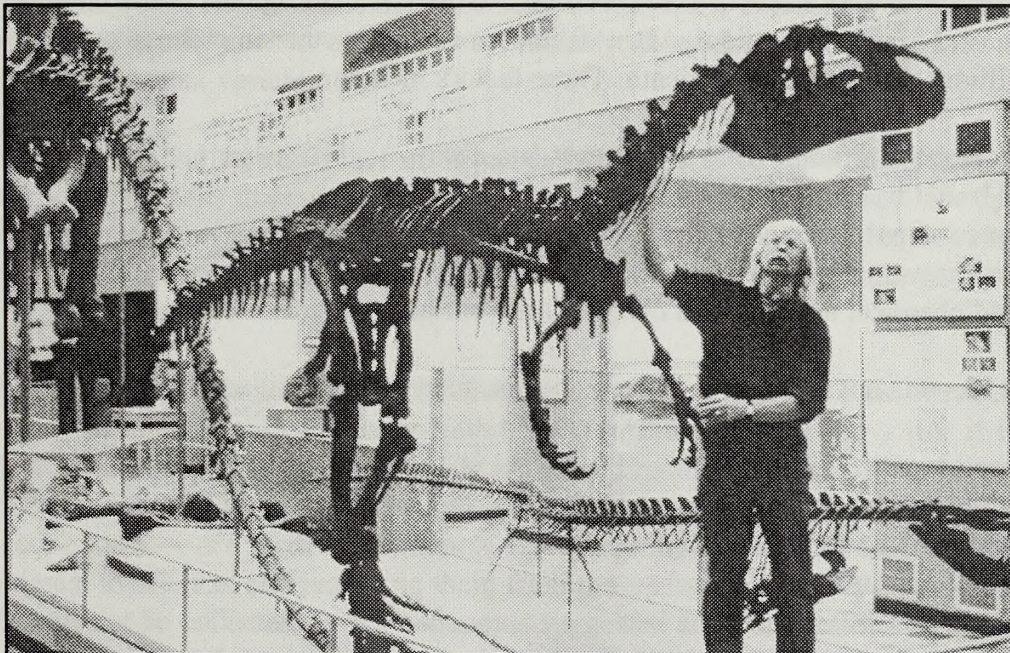
The consulting agencies have no recommendations concerning the management of fossils on Indian lands, since this should appropriately be addressed by tribal governments.

Federal Land

As a result of this Congressionally mandated assessment of federal fossil management, the consulting agencies have concluded that a coordinated approach to the appropriate protection and management of fossil resources would greatly enhance federal stewardship of these resources. Toward that end, the agencies recommend that future Congressional and administrative actions regarding fossils on federal land be governed by the following principles.

Principle 1: Fossils on Federal Lands are a Part of America's Heritage

Americans share in a unique natural legacy. This country, alone in the world, is home to icons such as *Allosaurus*, *Deinonychus*, *Pentaceratops* and *Stegosaurus*. Other fossils, less vivid in the public imagination than dinosaur skeletons, are no less wonderful and no less our own. Perfect leaves and flowers from Colorado and Utah, a delicate tracery of dinosaur tracks on a 165-million-year-old beach, schools of fish (perfectly filleted by scavengers and decay) that swam in what is now the desert landscape of Wyoming, forests of ancient redwoods in New Mexico, the oldest known parrots from tropical Montana — all of these are preserved in the care of the nation. We are enriched by their collective ownership and impoverished in many ways by their loss.



Museums display important specimens from federal lands.

We are particularly fortunate in receiving a legacy on federal lands that has not been squandered by earlier generations or scattered to the corners of the globe. Thomas Jefferson made clear to Lewis and Clark that some of their discoveries would have commercial value, but that some were to be brought back to the East and preserved for study. Part of their collection has survived for nearly 200 years. Jefferson himself studied a fossil ground sloth that he kept in the East Wing of the new White House.

Even this emphasis on preservation and study would have limited effect on the study of fossils if all of North America were covered by lush vegetation. The steep, arid and deeply eroded terrains on federal lands in the West are the places where fossils are best preserved and most often found.

The earliest trappers and traders sent fossils East, and well before the Civil War, the predecessors of the U.S. Geological Survey had arrived to collect them in great numbers for safekeeping in the Smithsonian Institution. The combination of a national inclination to explore, a perfect landscape, a fascination with science, a desire to preserve and the money and leisure to pursue these goals, brought 19th century Americans into the 20th century with this natural heritage largely intact.

Fossils are elements of the human environment. Although they are not crucial to existence, like water and air, they offer intangible gifts to imagination and curiosity in the same ways that art and music enrich our lives. They remind us who we are, and how we might have come to be. Unlike archaeology, which seems near and familiar because we are studying ourselves, paleontology offers a pilgrimage to deep time. It lets us study what natural systems were like before human influence.

The fossil record always begins with a finite number of organisms that have any chance of being preserved, and only a few of them become fossils. The odds against preserving any plant or animal as a fossil are tremendous. Many factors must act together in order to preserve a specimen millions of years after its death. These factors include:

- protecting the remains from scavengers and decay,
- rapid burial by soft sediments like volcanic ash or mud,
- presence of parts that can be preserved easily,
- limited movement of the remains, either by running water or trampling by animals, and
- limited chemical and physical changes after burial.

Preservation alone is not enough. In order to be discovered, the fossil must be:

- exposed to view,
- seen by a human being,
- recognized for what it is, and
- collected appropriately.

We know only a little about the fossil record, and it consists mostly of gaps that remain to be filled. Unique and significant assemblages of fossils need to be protected as a national treasure for the enjoyment of all.

Federal agencies' current management practices further the paramount scientific and educational values of fossils. Efforts to regulate the collection of significant fossils, foster partnerships with educational groups and inform the public about opportunities on federal lands are part of each agency's goals.

Periodically, and in the course of this report, there have been some proposals to expand the use of fossils on federal land to include commercial uses. However, the great majority of comments received from the public strongly oppose such a change to existing policy. Two major professional paleontological societies, representing more than 3,000 members, issued a joint statement in October 1999, agreeing that, "because of the dangers of overexploitation and the potential loss of irreplaceable scientific information, commercial collection of fossil vertebrates on federal lands should be prohibited as in current regulations and policies." As a result, the consulting agencies have concluded that the broadest public benefit is derived from the use of fossils for their scientific, educational and, where appropriate, recreational values.

Recommendation: Future actions should reaffirm the current use of federal fossils for their scientific, educational and, where appropriate, recreational values.

Principle 2: Most Vertebrate Fossils Are Rare

"Rare" and "common" are subjective terms. In order to give them objective meaning when discussing fossils, we might start by thinking of relative rarity and absolute rarity. One comment noted that there can be thousands of microscopic fossils — such as foraminifera and diatoms — in a single teaspoon. These fossils might be seen as absolutely common worldwide, in certain rocks deposited on the ancient ocean floors. Similarly, invertebrate and plant fossils are relatively more common than vertebrates.

However, imagine the entire surface of the earth. Most of it is covered with water. Much of the land is covered by soil, trees and thick vegetation, and even where bare rock is exposed, it is often basalt, granite, or some other rock that yields no fossils. Where sediments are exposed, they commonly contain no fossils at all, or only a few. Finding fossils is the exception, not the rule.

We often fail to take this into account because Americans, especially in the West, have become so accustomed to places like Dinosaur National Monument that we believe this is the norm. In these few fortunate spots, vertebrate fossils are indeed relatively common, and we celebrate them only because such places are the exception. Only a few kinds of vertebrate fossils — fish scales, conodonts — are relatively common. Even seemingly worthless fragments may be of great interest to science, and removing them from the surface may mean that whatever lies beneath will not be collected. A few comments suggested additional efforts to track vertebrate fossils once they have been collected, but the difficulty and expense of implementing these approaches is unfeasible at the present time.

At issue is the public perception that many vertebrate fossils are so common that they should be made available for unrestricted collection. Several comments described the fossil fishes of the Green River basin in southwest Wyoming, in support of this argument.



Tyrannosaurus rex, one of the rarest of dinosaurs, is recognized by school children the world over.

Eocene (50 million years old) fish fossils from the Green River Formation do occur in large numbers, concentrated in a few layers of sediment and virtually absent from the rest. However, such deposits are extremely rare. There are only three such accumulations of Eocene fossil fishes in the world — in the Green River Formation, Wyoming, near Monte Bolca, Italy and at Messel, Germany. The majority of the productive layers are deeply buried, and the fossils can only be removed where the layers are eroded and accessible at the earth's surface. No doubt billions of fossil fishes exist in this "rare assemblage of common fossils," but only a fraction are accessible without tremendous effort. Illegal collection on federal lands has damaged hundreds of acres in the Green River Formation.

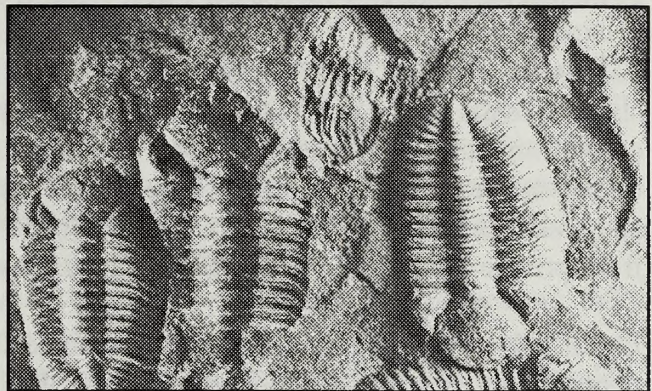
One comment received from a paleontologist also refuted the claim that fossil fishes from Southwest Wyoming are so common that they are not in need of protection. He referenced a single specimen and pointed out that even "After excavation of well more than a million 'fishes' over the last 140 years, this specimen is the first [pike] ever found in the [Green River] Formation (and the only complete [pike] skeleton known from the Eocene of North America)!"

A few other comments also attempted to make the case for a wealth of vertebrate fossils by describing great accumulations of bones. Regrettably, these are the exception and not the rule. Relatively few such accumulations, representing 500 million years of geologic time, are known in the entire world. A fraction of them are on federal land in the United States. Rather than agree to their exploitation, we should be astonished by their existence and treat them with the respectful awe reserved for the very old.

The restriction of vertebrate fossil collection to qualified personnel is one example of a unified federal policy. Some commenters requested a reconsideration of this long-standing federal approach. However, in light of the scientific value of these resources outlined above, and the majority of comments we received from the public, the consulting agencies agree that the policy should remain in place.

Recommendation: Future actions should reaffirm the restriction of vertebrate fossil collection to qualified personnel, with the fossils remaining in federal ownership in perpetuity.

Principle 3: Some Invertebrate and Plant Fossils are Rare



Trilobites, other common invertebrates, and plants may be collected by amateurs on BLM-administered lands without a permit.

In general, invertebrates and plants are relatively abundant in the fossil record, and are more likely to be preserved than vertebrates. However, there are some kinds of plants and invertebrates that lived in environments so limited, or that survived such enormous odds against preservation and discovery, that they are just as rare as the rarest vertebrates. In west central Nevada, 15-million-year-old lake beds preserve delicate wasps, lacewings, beetles and ants in shales so thin they are called “paper shales.” Leaves of the ironwood tree, which now lives only on the Channel Islands of California, occur in the same place. This area is managed as one of the BLM’s Areas of Critical Environmental Concern (ACEC). Other locales with notable non-vertebrate fossil accumulations, such as Petrified Forest National Park and Florissant Fossil Beds National Monument, are managed by the NPS.

The acknowledgment that some invertebrate and plant fossils are rare does not mean that the public cannot enjoy them. For example, the NPS tries to ensure that all visitors to parks and to fossil repositories are able to see the fossils for which park units were created by allowing the collection of fossils for scientific or research purposes, and by specifying that all collected specimens remain in federal ownership.

Those who enjoy paleontology as a hobby are welcome to collect and retain a wide variety of plant and common invertebrate fossils on lands administered by the BLM. No permit is required, although there are some limitations (see Table 1), and the fossils may not be bartered or sold. Recreational use of BLM-administered lands is an increasingly important function, and limited casual collecting of petrified wood, invertebrates and plant material is a low-impact hobby that can be enjoyed by almost anyone on lands designated for such a purpose.

The consulting agencies received some input to indicate that the differences in collection policies for plant and invertebrate fossils may be confusing to the public. However, the agencies believe that the policies are in conformance with agency missions, and do not jeopardize the protection of scientifically significant fossils. At the same time, agencies have concluded that they should improve public understanding of their goals in the management of plant and invertebrate fossils.

Recommendation: Future actions should reaffirm mission-specific agency approaches to the management of plant and invertebrate fossils.

Principle 4: Penalties for Fossil Theft Should be Strengthened

Fossils from federal lands are used primarily for scientific and educational purposes. However, similar fossils on the open commercial market often have high monetary values. Those that play on our most basic impulses — appeal of the extraordinary, delight in beauty — may also play on our desires to own them and our willingness to pay dearly for the privilege. Thick catalogs and well-attended fossil shows make available a wealth of fossils that can be legally collected from private lands, and from state trust lands in a few Western states.

Escalating commercial values mean that increasingly, unauthorized collecting activity is spilling over onto federal lands. The loss of parts of the fossil record means the loss of important scientific and educational information about the history of life. These losses occur as a result of ignorance of the law or deliberate theft. In a study commissioned by the Forest Service, it was found that almost one-third of the paleontological sites surveyed in the Oglala National Grassland showed evidence of unauthorized collecting. In 1999, the NPS conducted a Servicewide survey identifying 721 documented incidents of paleontological resource theft or vandalism, many involving multiple specimens, in the national parks between 1995 and 1998. The NPS and the BLM can issue citations under their regulations, but the fine imposed is usually no more than \$100.

Two federal laws currently target the illegal collection or destruction of fossils. The Archaeological Resources Protection Act of 1979, 16 U.S.C. §§ 470aa-470mm (ARPA), authorizes penalties for illegal collections of paleontological resources. However, ARPA applies only to paleontological resources that were found in an “archaeological context.” The Federal Cave Resources Protection Act of 1988, 16 U.S.C. §§ 4301-4309 (FCRPA), authorizes misdemeanor-level penalties for illegal collections of paleontological resources from significant caves. Because these authorities address a limited subset of fossils, laws penalizing the theft or depredation of government property (18 U.S.C. § 641 and § 1361) now offer the primary protection

for fossils on federal lands. However, establishing the monetary value of a fossil, or damage done to a fossil, can be difficult.

Relatively few people, even within the federal judiciary, know how costly fossils have become, or how these high prices may persuade an unscrupulous few to collect illegally from federal lands. For most people, the idea that a single skeleton could bring as much as \$7.6 million at an auction is incredible or absurd. Even scraps of dinosaur bone, sold in plastic bags, cost \$3 — a large collection of these seemingly worthless bits might bring thousands of dollars to the seller. Additionally, potential expert witnesses can be reluctant to testify on the government's behalf as to the value of a stolen fossil because they believe that their testimony would further escalate commercial fossil prices. As a result of these factors, the fines currently imposed on fossil thieves are usually low compared to the lost resources. For example, one man who had stolen fossils from a national park over a period of years was fined a total of \$50.

Even if a stolen fossil can be recovered, crude collecting techniques may reduce its value through a loss of data, or damage to other specimens. Often, the most pronounced damage is the loss of the context and other significant scientific data, which is difficult to evaluate in monetary terms. In addition, theft and vandalism often cause other environmental impacts, including the loss of other significant resources. Although there is no way to recover such losses, penalties for inflicting the damage should at least be high enough to enhance the deterrent effect. The NPS is beginning to apply the Park System Resources Protection Act, 16 U.S.C. § 19jj, to fossil thefts for that very purpose. Although the agency has been successful in using innovative economic models to reach court-approved settlements under the Act, it remains to be seen whether these models adequately reflect the losses to science and education caused by fossil thefts.

To build more effective cases under the government property laws, managers, prosecutors, the public and the judiciary need to be better informed about commercial values, about the relative rarity of fossils that drives prices up, and about the scientific and educational values of fossils. Furthermore, the public can be made aware of successful prosecutions and penalties commensurate with the gravity of the offense. Public awareness is essential because it deters potential violators, and because it increases the public's sense of affiliation with the agencies that are protecting these resources.

The successful prosecution of individuals for theft or damage to fossils, using theft of government property laws, dates back only a few years. It is therefore reasonable to expect a long learning curve before all elements of the legal system work successfully in deterring and punishing these crimes. The consulting agencies are encouraged by two recent cases in which three individuals were convicted of theft of fossil fish worth approximately \$10,000 from BLM-administered lands in Wyoming. Two of these three people were also convicted of aiding and abetting in the thefts.

The consulting agencies are also beginning to cooperate on joint efforts, including interagency training, that are designed to shorten the learning curve. These efforts, modeled after those used to protect archeological resources, bring together scientists and law-enforcement specialists from the federal land management agencies to facilitate coordination and consistency.

However, the consulting agencies agree that, despite such efforts, fossils will continue to be lost unless more rangers, paleontologists and other trained personnel are made available to land managers at the field level.

***Recommendation:** Future actions should penalize the theft of fossils from federal lands in a way that maximizes the effectiveness of prosecutions and deters future thefts. Penalties should take into account, among other factors, the value of fossils themselves, as well as any damage resulting from their illegal collection. Future program strategies should emphasize education of federal managers, prosecutors, law enforcement personnel and the judiciary regarding the value of fossils and the techniques for the appropriate protection of fossil resources.*

Principle 5: Effective Stewardship Requires Accurate Information



Paleontologists collect data about dinosaur tracks in Wyoming.

Without a clear understanding of the paleontological resources on federal lands, agencies cannot effectively manage and protect these resources for the benefit of the American people. The consulting agencies use a variety of methods for locating and evaluating areas where fossils occur, based on their mandates, the acreage involved and their ability to use staff, technology and partners in the effort. Much of the initial work can be done by using new technology to search on-line databases and create computer models that integrate satellite images, vegetation and soil maps, and other spatial data in Geographic Information Systems (GIS). However, in many areas, on-the-ground inventories (“ground truthing”) must then be done to provide detailed information.

Information from the above efforts enables land managers to identify areas of scientific significance, assess natural or human-caused impacts, plan cyclic monitoring programs that prevent loss of important specimens to erosion, and evaluate requests for collecting permits. Such baseline information then improves the ability of the agencies to make informed decisions about resource stewardship, lets agencies identify museums and other repositories with collections of fossils from federal lands, and enhances opportunities for public education. More detailed inventories within repositories can also provide information about particular collections of fossils from federal lands. Finally, all these activities produce important new discoveries and opportunities for collaborative management. Amateurs can be important partners in paleontological inventories through participation in the supervised search for, excavation, preparation and curation of fossils from federal lands.

For example, an inventory at Channel Islands National Park revealed a virtually complete pygmy mammoth skeleton in rapidly eroding sea cliffs. A team of scientists and students from Northern Arizona University collected the skeleton and the associated geologic data, and it was prepared and studied at the Mammoth Site, Hot Springs, South Dakota. Intense public interest has prompted a partnership between the NPS and the Santa Barbara Museum to develop an exhibit on the pygmy mammoth. Subsequent surveys found more than 100 additional mammoth sites on the Channel Islands, documenting the progressive dwarfing of the island mammoths prior to their extinction.

The NPS has tested some of its inventory methods in Yellowstone National Park, resulting in publications, maps and increased staff awareness of paleontological resources. The increased staff awareness led to a fourfold increase in reports of paleontological resource theft or vandalism and to the identification of a number of new fossil sites.

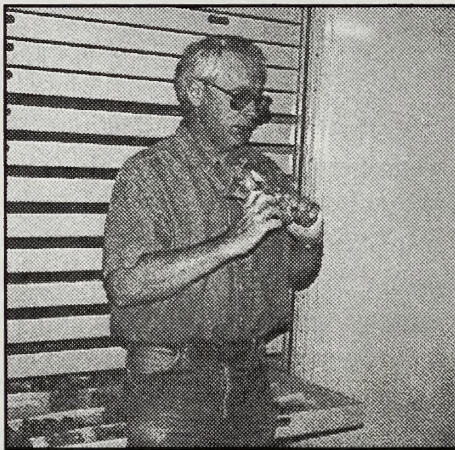
Some cost-effective strategies for inventory and monitoring efforts would best be achieved by establishing inter-agency and federal/non-federal partnerships. One current trend in paleontology is to assemble teams of experts from universities, museums and government agencies and then focus the team's energy on understanding a whole ancient ecosystem. A recent team study examined a 140-million-year-old ecosystem that stretched from Arizona to Montana, yielding new discoveries about dinosaurs and other animals, plants, climate and landscape. That work led to profound new interpretations that are being assembled into interpretive products for the public at visitor facilities in national parks, forests and BLM areas, and on the Internet. Such integrated approaches to inventorying paleontological resources are the most powerful means of enhancing our understanding of the history of life on earth and demonstrating the importance of protecting paleontological sites.

The limited paleontological inventories on federal lands accomplished to date have yielded exciting discoveries. Further inventories are likely to provide new evidence about the history of life. However, despite the availability of new technological approaches, inventory efforts for fossil resources in all the agencies are not conducted at the same level as the inventory of other resources.

Recommendation: Future actions should acknowledge the need for gathering and analyzing information about where fossils occur, in particular the critical role of inventory in the effective management of fossil resources. Increased emphasis on fossil inventory should take into consideration, where possible, regional approaches across agency lines, using modern technology such as GIS. Such work could also address specific issues, such as the impact of erosion on the loss of resources.

Principle 6: Federal Fossil Collections Should be Preserved and Available for Research and Public Education

To maximize the availability of fossils for scientific study and for the public, fossils collected under a permit from federal lands must remain in public ownership where they can be accounted for and made available for repeated research and educational projects. Paleontologists cannot “experiment” with their subjects in the way that chemists or physicists can, so instead they must observe, describe and analyze what they see. Often, these observations are carried out repeatedly as the science advances, so the need for long-term care of fossils, whether in storage or on exhibit, is critical. For example, unlike 20 years ago, scientists now CAT-scan fossils. The long-term presence of fossils in exhibits and displays may be critical as well, especially to children who enjoy a story over and over, admiring its permanence in their lives and learning new things each time they revisit it.



Museums house important fossil specimens from federal lands.

Fossils and data together form the fabric of paleontology. But like a complex tapestry of fragile threads, the fabric cannot be re-woven once it has been separated. The sediments at a fossil locality cannot be put back in context once they have been dug into and moved. Trained permittees begin the process of collecting fossils and data in context, and it is the work of museums and other repositories to maintain that context. The Department of the Interior has established standards for its own repositories and for other institutions that house its collections and data.

Some commenters were concerned about excessive handling of specimens by the public; others felt that specimens are locked up in museum basements and inaccessible to all except an elite few. Both these views need to be addressed by agencies that serve the public. Agencies must develop and disseminate information about what fossils are in the public trust and how people

can feel a sense of ownership. At the same time, agencies try to ensure that these fossils are professionally preserved and managed.

Many of the comments received from museums and universities detailed the thousands or millions of visitors who see their exhibits every year, the thousands of specimens collected under permits issued by the consulting agencies, and the hundreds of students who use specimens from federal lands in their studies. Both Americans and foreign visitors go to these settings, and millions more visit national parks, monuments, BLM-administered lands and National Forest System lands, to experience fossils more directly.

Despite the balancing act required for effective preservation and access, it is clear from the comments received that the public believes that scientifically important fossils are a part of their heritage. In the words of one commenter, “Why should my daughter care about the United States when it has become nothing but a commercial [‘fossil collectors’] center for profit? What kind of interest in science will her children have if the tools and subjects of scientific study are locked away in someone’s private collection?”

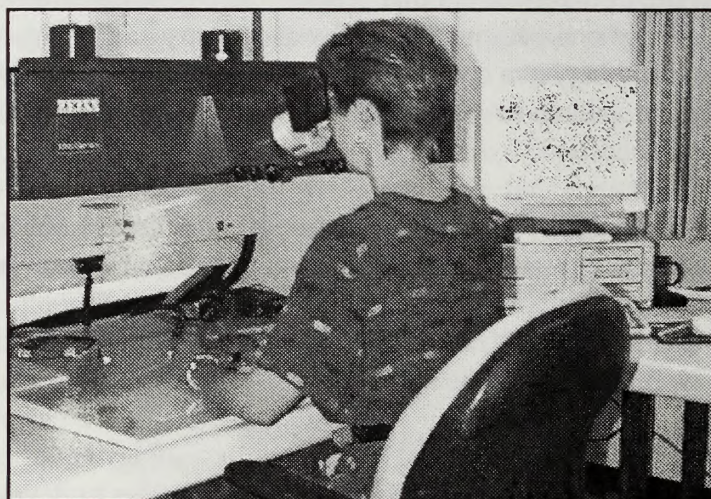
Agencies work with a wide range of repositories to house these collections, including federal repositories, large research institutions and small community-based institutions. This approach allows agencies to meet the needs both of researchers and the general public. The long-standing partnership between museums and federal agencies for the curation of scientifically valuable fossil resources works well. However, the steady increases in collections and demand for more effective access by researchers and the public strain the financial resources of the federal government and the museum community. The use of modern technology could effectively address some of these concerns, but requires shared use of the tools in order to develop the most effective approaches. The consulting agencies, with specific input from the Smithsonian Institution, believe that four steps could be taken to enhance the value of existing museum fossil collections. The steps are as follows:

- complete the capture of information in digital format for existing collections, including those that are uncataloged;
- make full information from databases of specimen information available online over the Internet to qualified researchers and land managers;
- make general information about the collections available to the public via the Internet; and
- capture digital images of specimens and link these images to specimen databases so that both researchers and interested amateurs can view their fossils over the Internet.

The following benefits could result from posting collections information and images online:

- Museum collections could become a tremendous educational resource for teachers at all levels across the entire country. For example, a teacher in Wyoming could use the Internet in his/her classroom to query a database of the Smithsonian Institution in Washington, D.C., about fossils collected in a Wyoming county, and be able to display pictures of those fossils to the class.

- Online images and databases could be a major source of information to amateurs and hobbyists. A collector in Iowa using a digital database and picture could identify a crinoid fossil found in his/her backyard.
- Enhanced online information would also give land managers some of the information they need about the resources under their jurisdiction. They could answer questions such as: what fossils in their area have been collected, which fossils are rare, and who should they turn to for more technical information about a particular fossil occurrence?
- Online databases would improve the efficiency of scientific investigations by allowing scientists to access records from multiple museums, and to view specimens prior to or instead of traveling. The greater efficiency for scientists would result in an increase in the knowledge generated from federal collections.



BLM staff using a stereo plotter to draw contour maps of dinosaur footprints.

Recommendation: Future actions should affirm the importance of curating scientifically valuable fossils as federal property, often in partnership with non-federal institutions. Future program approaches should emphasize the use of modern technology to improve curation and access, as well as the sharing of information between and among government agencies and other institutions.

Principle 7: Federal Fossil Management Should Emphasize Opportunities for Public Involvement

None of the principles discussed above can be implemented without the endorsement and support of the American people. Agencies, no matter how much they wish to, cannot do the whole job of caring for this part of America's heritage. All the consulting agencies currently foster the involvement of the general public — amateurs, volunteers and students — in a variety of opportunities in paleontology on federal lands, depending on that involvement to foster a sense of ownership so that each citizen can become a steward of the past. More opportunities should be identified by consulting agencies with this goal in mind. For some agencies, amateur and volunteer opportunities might include training, assisting an agency with fossil inventory for land use planning and resource management, or working alongside professional paleontologists



BLM staff and volunteers unearth "Tony's Tree," the first Jurassic tree from east of the Rocky Mountains.

as they do inventories, survey and collection of fossils for research and scientific projects, exhibitions and protection and preservation. Continued recreational collecting of plants and common invertebrates on BLM-administered lands provides the kind of hands-on involvement that builds powerful attachments to the land and the resource. NPS lands offer visitors an equally valuable experience — resource education tempered by a resource protection message.

An excellent example of a partnership between government and the public is the Dinosaur Depot in Cañon City, CO, the museum of the Garden Park Paleontological Society (GPPS.) The GPPS originated as a local volunteer interpretive group that conducted tours of the Garden Park Fossil Area, one of the earliest collecting sites of the "dinosaur hunters" of the late 1800's. The GPPS also helps the BLM with management and protection of the paleontological sites in the area. The museum is a result of local residents wanting to keep specimens collected from the Fossil Area in the community, and wanting to provide educational and recreational opportunities for the residents and tourists to enjoy. The museum now has a scientific collecting permit, a professional curator, and repository status with the BLM. Their amateur volunteers are certified to collect, prepare and maintain the collections, and the volunteers in turn teach BLM staff how to foster similar groups in other areas.

Information from fossils is also available in databases and in interpretive displays such as those in NPS units, BLM-administered lands and FS special sites. The public may participate in paleontological investigations through the FS Passport in Time projects, as NPS Volunteers in Parks and as other federal land agency volunteers. The public may also participate in activities on federal lands sponsored in partnership with other organizations. The USGS National Paleontological Database is currently under construction.

Failure to involve the public in the preservation of its heritage will certainly result in the loss of rare, beautiful and significant resources, either through misuse or neglect. People who are well informed about what is at stake, and about their role in ensuring that their children will enjoy America's fossil heritage, can be counted on to protect this legacy.

Recommendation: Future actions should include an emphasis on public education and participation in the stewardship of fossil resources. Future program approaches should emphasize the use of technology to increase public education and awareness of the importance and benefit of fossil resources.



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GLOSSARY

The consulting agencies agree that the definitions below represent broadly the meaning of these terms for purposes of this report. Slightly different definitions may appear in the policy documents of each agency.

- Allosaurus*: Meaning “different lizard,” was a large carnivorous dinosaur from the Late Jurassic Period, about 145 million years ago. It lived in what is now the western United States. It was about 34 feet (10.5 m) long and weighed about 3100 pounds (1400 kg). The type species is *A. fragilis*.
- Conodonts: Teeth of very early fish-like creatures that lived about 515 million years to 210 million years ago.
- Crinoids: A large class of echinoderms usually having a somewhat cup-shaped body with five or more feathery arms.
- Curation: The management, preservation and use of museum objects/specimens, which includes acquisition and disposal, documentation and cataloging, preventive conservation, storage, access, interpretation and exhibition, and research and publication.
- Deinonychus*: A carnivorous dinosaur from the Cretaceous Period, about 100 million years ago. This small, intelligent biped was about 10 feet (3m) long, weighed up to 175 pounds (80 kg) and had a 5 inch (13 cm) long, sickle-shaped claw on each hind foot. Several skeletons have been found in Montana, Utah and Wyoming. It was named by paleontologist J. Ostrom in 1969. The type species is *D. artirrhopus*.
- Eocene: Relating to, or being an epoch of the Tertiary Period between the Paleocene and the Oligocene or the corresponding system of rocks. About 55 to 35 million years before the present.
- Fossils: Fossils are the remains, traces or imprints of organisms preserved in the earth’s crust. Fossils have been found on every continent on Earth.
- Invertebrates: Animals lacking a backbone or spinal column.
- Multicellular: Having many cells.
- Mission-specific: Specifically related to the mission and goals of an agency.
- Non-renewable: Not capable of being replaced or replenished.
- Organisms: Living things.

Paleontology: A science dealing with the life of past geological periods as known from fossil remains.

Pentaceratops: Meaning “five-horned face,” this was a large ceratopsian dinosaur from the Late Cretaceous Period, about 75-65 million years ago. This plant-eater had a very large, bony, scalloped head frill, a snout horn, 2 larger, forward facing horns above its eyes, and 2 pointed, horn-like cheek bones. Its enormous skull was up to 9.8 feet (3 m) long. *Pentaceratops* was up to 28 feet (8 m) long. Fossils have been found in New Mexico. It was named by paleontologist Henry F. Osborn in 1923.

Recreation: Use of leisure time to freely engage in activities in a variety of settings which provide personal satisfaction and enjoyment and contribute to the “renewal” and “refreshment” of one’s body, mind and spirit.

Recreational Collecting: Collecting and retaining fossils as a recreational activity on BLM-administered lands. See above.

Stegosaurus: Or “roof lizard,” was a plant-eating ornithischian dinosaur that had armored plates along its back and spines on the tail. It lived during the Late Jurassic Period, about 145 million years ago.

Vertebrates: Animals with a backbone or spinal column. Dinosaurs were vertebrates. People are also vertebrates.

APPENDIX A. SUMMARY OF MANAGEMENT BY AGENCIES

Bureau of Land Management

The Bureau of Land Management (BLM) is charged with retaining the public lands in Federal ownership, planning for their future use through systematic inventory, protecting the quality of scientific and other values, and managing lands for multiple use and sustained yield. In carrying out this mission, the BLM manages fossil resources for their scientific, educational and recreational values in collaboration with museums and other groups. The great majority of the fossil record — invertebrates, plants and petrified wood — is available for the enjoyment of hobbyists, school groups and the general public. A permit is required for the collection of scientifically important fossils such as vertebrates, and such specimens and data must be placed in repositories where they remain the property of all Americans. The BLM supports the development of exhibits featuring federally associated collections, and the display of exhibit-quality specimens in local museums.

Because the BLM administers some 264 million acres of federally-owned surface, detailed inventories to locate fossils are impractical except on a case by case basis. However, as part of the National Environmental Policy Act (NEPA) process, the BLM considers the impact to fossil resources when evaluating surface-disturbing projects such as pipelines or roads, and in the development of realty exchanges. The BLM maintains a professional staff of paleontologists who work with those from other land managing agencies to develop and provide training and to coordinate other interagency functions. Law enforcement officers in critical areas are available to work with paleontologists in preventing damage and loss of this resource.

Bureau of Reclamation

The mission of the Bureau of Reclamation (BOR) is to manage, develop and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Through leadership and the use of technical expertise, efficient operations, responsive customer service and the creativity of people, the Bureau of Reclamation seeks to protect and preserve natural resources. Fossils are among these natural resources, and the BOR protects them through a permit process. The Bureau of Reclamation has no law enforcement authority at this time, but has drafted and submitted legislative language to establish limited law enforcement capabilities. On BOR-administered lands, a permit is required to collect any kind of fossils.

Fish and Wildlife Service

The mission of the U.S. Fish and Wildlife Service (FWS) is working with others, to conserve, protect and enhance fish, wildlife and plants and their habitats for the continuing benefit of the American people. As part of this mission, the FWS manages an extensive network of lands that are administered as part of the National Wildlife Refuge System.

In addition to sustaining important wildlife and their habitat, national wildlife refuges protect other important resources such as fossils. Fossils are protected under regulations published in 50 CFR Parts 26 and 27, which require that a permit be issued by the FWS to search for and collect fossils on refuges. Permits are issued to reputable scientific and educational institutions that can demonstrate sound research objectives and ensure the long-term care of Federal collections for study and public appreciation.

Forest Service

The USDA Forest Service (FS) is dedicated to caring for the land and serving the people, and to protecting and managing the paleontological (fossil) resources that are important to our natural resource inheritance. The FS will meet its Natural Resource Agenda by providing leadership, technical assistance and support for all forests in the protection and management of our paleontological resources. The FS recognizes multiple-use values for paleontological resources that include a legacy for present and future generations; scientific significance, education and interpretation; recognition of aesthetic qualities; and public participation.

The FS will continue to enhance its resource protection mandates for the protection and preservation of its fossil resources; will continue to foster partnerships and collaborations with other land managing agencies, and educational and scientific institutions; and provide opportunities for public participation and enjoyment of its natural heritage.

National Park Service

As required by its Organic Act, 16 U.S.C. §§ 1 *et seq.*, the NPS strives to conserve paleontological resources in park units and provide for their enjoyment so that they are unimpaired for the enjoyment of future generations. The current *NPS Management Policies* establish the following mandates for NPS paleontological resource management:

“Paleontological resources, including both organic and mineralized remains in body or trace form, will be protected, preserved and developed for public enjoyment, interpretation and scientific research in accordance with park management objectives and approved resource management plans.

Paleontological research by the academic community will be encouraged and facilitated under the terms of a research permit when it meets all of the following criteria:

- The project cannot be conducted outside the park and involves more than simple collection of additional specimens of types already collected.
- The project will answer an important question about the resource.
- Information obtained through the research will be made available to the park. Management actions will be taken to prevent illegal collecting and may be taken to prevent damage from natural processes such as erosion. Protection may include construction of shelters over specimens for interpretation in the field, or collection, preparation and placement of specimens in museum collections. The localities and geologic settings of specimens will be adequately documented when specimens are collected.”

The *NPS Management Policies*, including those governing paleontological resource management, are currently under revision.

The Smithsonian Institution

The Smithsonian Institution is a trust instrumentality of the United States. Within the context of the Smithsonian's mandate to "increase and diffuse knowledge among men," extant since 1846, and the charge of the National Museum of Natural History (NMNH) for research, collection and exhibition of natural history objects, is its traditional stewardship of what are considered "national treasures." This stewardship is intended to ensure the protection and conservation of fossil evidence of past forms of life, and to make this evidence available for scientific studies, both now and in the future. The Department of Paleobiology is charged with being the national repository for one of the world's largest fossil inventories of more than 40 million lots of fossils representing 480 separate collections. More than 50% of its present collections are from federal lands. According to 20 U.S.C. § 59, "All collections of rocks, minerals, soils, fossils and objects of natural history, archaeology and ethnology, made by the National Ocean Survey, the United States Geological Survey, or by any other parties for the Government of the United States, when no longer needed for investigations in progress shall be deposited in the National Museum."

The identification of a fossil as a national treasure requires paleontological expertise, which is represented among the various specialities on the staff of the Department of Paleobiology, NMNH. In addition to recognition of the scientific importance of new fossil finds, this expertise also includes knowledge of their care and maintenance, a responsibility to the public, the scientific and educational community, and a respect for the future needs of particular fossils (type specimens) as unique standards of reference. A main purpose for research in the NMNH is to understand the context of the collections under its care. It is also to inform the public of their importance by publications, exhibition and various means of education. In scope, whereas the NMNH occupies a place near the center of pride in the monumental city of Washington, D.C., its role as a "national museum" reaches out to share its treasures as much as possible to those parts of the country from which they come.

The U.S. Geological Survey

The USGS is a world leader in the natural sciences through its scientific excellence and responsiveness to society's needs. The agency serves the Nation by providing reliable scientific information to describe and understand the Earth, minimize loss of life and property from natural disasters, manage water, biological, energy and mineral resources, and enhance and protect our quality of life.

The USGS employs more than 50 research paleontologists dedicated to applying paleontological methods and support to meeting our Nation's needs. A small, but important, part of that effort is supplying paleontological expertise in land-management decisions and developing and delivering the National Paleontologic Data Base, an Internet data base management system of paleontological resources.

APPENDIX B. SUMMARY OF COMMENTS

Summary of Public Comments from *Federal Register* Notice, 64 FR 27803-27804, May 21, 1999 and Public Meeting, June 21, 1999

This section summarizes the comments received at the open meeting and during the public comment period for the background paper on the collection, storage and preservation of fossil resources on federal lands. The "Action or Response" column indicates how comments were addressed in the draft report. Comments have been paraphrased in order to integrate the major points.

Comment	Action or Response
Fossils are a rare, non-renewable resource and part of our natural heritage.	Incorporated into Principles 1 and 2.
Fossils of extinct groups are non-renewable; more will be discovered but from a finite supply.	Incorporated into Principle 1.
A fossil collected without contextual data has often lost much of its value.	Addressed and considered in Principle 4.
Only when specimens are properly collected and curated in public institutions are they accessible for research and study. The general public benefits through various kinds of access to these public institutions.	Incorporated into Principle 6.
Vertebrate fossils from public lands are an educational and scientific resource that should remain in the public domain, preserved for the enjoyment of all.	Incorporated into Principle 2.
Existing federal laws are inadequate to protect vertebrate fossils and to ensure the broadest access for citizens.	Considered in Principles 4 and 6.
Penalties for illegal collection of fossils are ineffective, as they do not act as deterrents to those enticed by the high commercial value commanded by many vertebrate fossils.	Considered in Principle 4.
Prohibit commercial collection from public lands because such collection leads to the loss of contextual data, resulting in a reduction of the fossils' scientific value.	Considered in Principles 1, 4 and 6. The possibility of commercial collection of fossil specimens from public lands was reviewed, but ultimately was determined not to be a viable option because of the likely loss of scientific and educational information and public enjoyment. Few comments supported commercial collection on federal lands. Fossils for commercial use may be collected from non-federal lands.

Comment	Action or Response
<p>Most invertebrate and plant fossils are fairly common, and their collection should not require a permit. Favor continuing the existing policies of some agencies that allow collection of these fossils for noncommercial use.</p>	<p>Considered and incorporated in Principle 3. See Table 1. Each agency has laws and regulations that govern collecting on lands they administer.</p>
<p>Not all vertebrate fossils are rare.</p>	<p>Considered in Principles 1 and 2. Current scientific evidence indicates that the majority of vertebrate fossils are rare.</p>
<p>Amateurs, hobbyists and commercial fossil collectors may lack the knowledge and experience to collect fossils and data appropriately. No one should collect scientifically significant specimens without professional oversight. Only qualified individuals should be issued permits for collecting scientifically significant fossils on public lands.</p>	<p>Considered in Principle 7. The agencies and most paleontologists and institutions recognize the contribution of amateur collectors to science and education. Many programs provide training by professionals. Professional paleontologists may be assisted by properly trained amateurs in the field, and amateurs with appropriate training may qualify for permits. See Table 2.</p>
<p>Some vertebrate fossil specimens can remain in the ground, properly protected, for later collection.</p>	<p>Considered in Principles 5 and 7. The agencies recognize, from their land management activities, that fossils are lost to erosion. With proper field techniques, specimens can be left in place for later collection. Proper protection of specimens left in place at the end of the field season for later collection is a permit requirement. Agencies are using cyclic monitoring in highly erosive areas to prevent loss of important specimens.</p>
<p>There is a need for a uniform federal policy with consistent regulations in regards to fossil resource management. Uniform regulations would provide better customer service and consistency in the permit application process between agencies.</p>	<p>Considered in the overall report and the 7 principles. The land management agencies have different mandates for land use and resource management that may not make possible consistent regulations for all agencies. However, where mandates are similar, the agencies are striving for better customer service through consistent policy. Policies on collection of vertebrates, prohibition of commercial collection and treatment of significant specimens are similar or identical.</p>
<p>State clearly what is open for the public (amateurs and hobbyists) to collect.</p>	<p>Considered and addressed in Principle 3. See also the Executive Summary and Table 1. BLM allows the collection of most invertebrate and plant fossils without a permit on the lands it administers. BLM also allows the collection of limited amounts of petrified wood (a mineral material).</p>

Comment	Action or Response
There is a need for a clear definition of fossils, as well as what can be collected under a permit by qualified parties.	Considered in Principles 2 and 3. "What is a fossil" is discussed in the background paper and the glossary of this report.
The federal government should financially aid the public repositories that hold federal fossil collections through partnerships and funding.	Considered and addressed in Principle 6.
There is a need for uniform standards for curation, preservation and storage for repositories and a uniform national database using new technologies for cataloging, preserving and presenting data.	Considered and incorporated into Principles 5 and 6.
Fossils are destroyed by erosion and weathering; therefore uncollected fossils may be lost forever.	Considered in Principles 5 and 7. The agencies recognize from their land management activities that fossils are lost to erosion. With proper field techniques, specimens can be left in place for later collection. Proper protection of specimens left in place at the end of the field season for later collection is a permit requirement. Agencies are using cyclic monitoring in highly erosive areas to prevent loss of important specimens.
Most invertebrate fossils, all plant fossils and some vertebrate fossils are renewable resources.	Considered in Principles 2 and 3, and Executive Summary. The report clarifies that fossils are not renewable in the sense that no more will be made although more will be discovered.
Amateur and commercial collectors have contributed a great deal to the science of paleontology, donating important fossil specimens when professional paleontologists had no time or funds to do field work.	Considered in Principle 7. The agencies and scientists recognize the valuable contribution of amateur collectors to science and education.
Not all fossil specimens are suitable for curation and preservation in a public institution.	Considered in Principles 3 and 6, and in Table 1. Many kinds of fossils on public lands are available for amateurs to collect without a permit.
Not all fossil collections in museums are accessible to the public.	Considered in Principle 6. Most specimens in museums are collected for scientific interest and have limited general appeal. They are often too fragile to survive handling, but displays and publications based on what is learned from them are publicly available.
There is not enough space in repositories to house all the specimens found on federal lands nor enough dollars to excavate and curate them all.	Considered in Principle 6. Effective partnerships with museums of all kinds have so far provided housing for federal specimens as needed.

Comment	Action or Response
New legislation and policy are needed that would permit any interested party to collect any fossil from public lands. Of the fossils collected, scientifically significant fossils would be made available by the collector for research and study.	Considered in Principles 2, 3 and 7.
Commercial collection is good for the economy — it creates jobs and creates influx into the tax base.	Considered in Principle 1. Fossils for commercial use may be collected from non-federal lands.
Support for the National Academy of Sciences (NAS) report on “Paleontological Collecting” recommendations.	Considered throughout the report. Federal agencies have already implemented as many of the NAS recommendations as possible under the current legal framework.

This section summarizes the comments received during the public comment period on the draft report "Assessment of Fossil Management on Federal and Indian Lands," and how the comments were addressed in the final report. Comments have been paraphrased in order to integrate the major points.

Comment	Action or Response
The seven principles form a sound basis for proper stewardship of these valuable resources.	Incorporated into the final report.
The seven principles create a foundation for partnerships with DOI in ensuring public benefit.	Incorporated into the final report.
Fossils from federal lands are part of America's heritage. Museums and universities are proud to share these resources with visitors and students.	Incorporated into the final report as Principles 1 and 6.
Vertebrate fossils are extremely rare, as are some invertebrate and plant fossils.	Incorporated into the final report as Principles 2 and 3.
Understanding the significance of fossils depends on collection by qualified personnel who also collect pertinent contextual data.	Incorporated into the final report as Principle 1.
By keeping these fossils at public institutions, knowledge gained from scientific studies is shared with the public.	Incorporated into the final report as Principles 1 and 6.
Collection of fossils on federal lands should be overseen by qualified individuals and institutions that curate and store specimens.	Incorporated into the final report as Principles 2, 3, and 6.
Hundreds of volunteers and amateur paleontologists are involved in museum and other institutional programs and have made fossils accessible to all.	Incorporated into the final report as Principle 7.
Recommendations in the draft report will allow for continuing development of partnerships between amateurs and professional paleontologists.	Incorporated into the final report as Principle 7.
Theft from federal lands is a serious problem, and increased fossil prices dictate increased penalties as effective deterrents.	Incorporated into the final report as Principle 4.
The recommendations in the draft report will ensure that the people of the U.S. receive full benefits from this valuable public resource.	Addressed throughout the final report.
The recommendations in the draft report will ensure that effective stewardship of our important fossil resources can be accomplished.	Addressed throughout the final report.

Comment	Action or Response
No change is needed in existing legislation and regulations. Additional legislation would inhibit people's rights to collect fossils.	Addressed in Principles 3 and 7, and in Executive Summary.
Legislation for fossil protection should include private and state lands, or federal actions on private lands. Treatment of valuable fossils on Indian lands should be changed.	Not requested in this report (see the Introduction). The trust relationship between the federal government and Indian tribes is defined under section III, Management of Fossils on Indian Lands.
Please clarify the term "recreational collecting."	This definition has been added to the Glossary.
What is a "qualified paleontologist," and why cannot people with collecting experience qualify for collecting permits? Most universities do not offer that degree; what about work experience and training?	See Table 2. Permit holders must have professional training. Amateurs with professional training may qualify for permits.
Individuals who inadvertently collect "significant invertebrate and plant fossils" could be penalized.	See Executive Summary, Table 1, and Principle 3.
There is not enough space in repositories to house all the specimens found on federal lands nor enough dollars to excavate and curate them all.	Considered in Principle 6. Effective partnerships with museums of all kinds have so far provided housing for federal specimens as needed.
We are concerned about continued access to invertebrate and plant fossils by amateurs.	Considered in Principle 3. See Executive Summary and Table 1.
Amateurs should be able to collect "common" vertebrate fossils, e.g., shark teeth, or "insignificant" vertebrate fossils, e.g., isolated bone fragments ("float bone").	Considered in Principle 2.
Some institutions have fossil collections that are not available to the general public or amateurs.	Considered in Principle 6.
All fossils are not rare, but abundant.	Considered in Principles 1, 2 and 3. Current studies document that the majority of vertebrate fossils are rare.
Please consider the recommendations of the National Academy of Science (NAS) report on "Paleontological Collecting."	Federal agencies have already implemented as many of the NAS recommendations as possible under the current legal framework.
Fossils must be collected before they are lost to weathering and erosion.	Addressed in Principles 4, 5 and 7.
Allow commercial collection of all fossils. Commercial collectors should be allowed to collect for museums and other institutions, as well as for sale and trade.	Considered in Principle 1. Fossils for commercial use may be collected from non-federal lands.

Comment	Action or Response
Commercially valuable fossils require protection.	Considered in Principles 2 and 4.
Fossils should be not be sent to the Smithsonian, but housed in museums in the state where they were found.	Most fossils from federal lands are kept at the university or museum responsible for collecting them, and often this is close to the site of discovery. Fossils in the Smithsonian are labeled so that visitors (up to 7 million a year) know where they came from. They are available for study by scientists from around the world.

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